

**Species List of Research Needs
In Support of U.S. Fish and Wildlife Service Recovery Plans
September 2009**

PLANTS

Antioch Dunes evening-primrose (*Oenothera deltoids ssp. howellii*)

1. Grazing research
2. Research of life history, habitat requirements
3. Annual population monitoring

Baker's larkspur (*Delphinium bakeri*)

Bakersfield cactus (*Opuntia treleasei*)

1. Population monitoring
2. Matrix projection modeling
3. Systematics and genetics

Burke's goldfields (*Lasthenia burkei*)

1. Determine effects of road run off on vernal pool species
2. Research on effective eradication of non-native competitors
3. Develop and implement standardized population trend survey protocols to update status surveys, especially on private lands
4. Conduct research to assess specific physical and hydrological requirements for these species to address relationships between species occurrences and landform, soil chemistry, geographic location, and precipitation regimes
5. Conduct research on the reproductive ecology, gene flow patterns, and seed bank dynamics comparing established restoration sites and remaining natural sites to gauge restoration efficacy

Butte County meadowfoam (*Limnathes floccose spp. californica*)

1. Genetic studies
2. Study taxonomy
3. Study species biology
4. Develop standardized monitoring
5. Survey on private land
6. Data analysis using GIS
7. Controlled propagation, introductions, reintroductions
8. Standardize surveys/determine probability of detection
9. Determine dispersal mechanisms
10. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
11. Investigate methods to monitor ecosystem function and response
12. Study genetics in relation to potential reintroductions
13. Population viability analysis

14. Identify methods to remediate lead contamination
15. Study effects of fire, livestock
16. Develop hydrological models
17. Study vernal pool restoration methods
18. Compare constructed and natural pools
19. Survey for plants, pollinators
20. Determine effects of non-natives
21. Determine preferred habitat (soils, hydrology)
22. Determine effects of road run off on vernal pool species

California jewelflower (*Caulanthus californicus*)

1. Conduct research and monitoring tasks in Santa Barbara Canyon
2. Conduct surveys at Cottonwood Pass
3. Propagate in greenhouses and reintroduce to appropriate habitat as necessary (efforts to date have failed, need new effort)
4. Matrix projection modeling
5. Investigate physical, chemical, and biological successful properties of the soil required for (re)establishment

Calistoga allocarya (*Plagiobothrys strictus*)

Chinese Camp brodiaea (*Brodiaea pallida*)

1. Determine extent of extant populations
2. Monitor status and trends
3. Survey for species beyond serpentine soils

Clara Hunt's milk vetch (*Astragalus clarianus*)

1. Conduct 3 years of surveys and threats assessments

Clover lupine (*Lupinus tidestromii*)

1. Population monitoring
2. Disturbance monitoring
3. Remap distribution using GIS
4. Study effects of grazing
5. Determine habitat requirements
6. Monitor population trends
7. Survey likely habitat

Colusa grass (*Neostapfia colusana*)

1. Genetic studies
2. Study taxonomy
3. Study species biology
4. Develop standardized monitoring
5. Survey on private land
6. Data analysis using GIS
7. Controlled propagation, introductions, reintroductions

8. Standardize surveys/determine probability of detection
9. Determine dispersal mechanisms
10. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
11. Investigate methods to monitor ecosystem function and response
12. Study genetics in relation to potential reintroductions
13. Population viability analysis
14. Identify methods to remediate lead contamination
15. Study effects of fire, livestock
16. Develop hydrological models
17. Study vernal pool restoration methods
18. Compare constructed and natural pools
19. Reintroductions
20. Determine effects of road run off on vernal pool species

Contra Costa goldfields (*Lasthenia conjugens*)

1. Genetic studies
2. Study taxonomy
3. Study species biology
4. Develop standardized monitoring
5. Survey on private land
6. Data analysis using GIS
7. Controlled propagation, introductions, reintroductions
8. Standardize surveys/determine probability of detection
9. Determine dispersal mechanisms
10. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
11. Investigate methods to monitor ecosystem function and response
12. Study genetics in relation to potential reintroductions
13. Population viability analysis
14. Identify methods to remediate lead contamination
15. Study effects of fire, livestock
16. Develop hydrological models
17. Study vernal pool restoration methods
18. Compare constructed and natural pools
19. Research control of invasive plants
20. Research genetic structure
21. Pollination research
22. Determine effects of road run off on vernal pool species

Contra Costa wallflower (*Erysimum capitatum ssp. angustatum*)

1. Grazing research
2. Research of life history, habitat requirements
3. Annual population monitoring

Coyote ceanothus (*Ceanothus ferrisae*)

1. Survey historic and potential habitat
2. Research vegetation management techniques
3. Study soil seed bank
4. Investigate effect of nitrogen deposition
5. Research fire ecology

El Dorado bedstraw (*Galium californicum* spp. *sierrae*)

1. Population monitoring
2. Ecological studies
3. Research seed germination and propagation techniques
4. Research effects of fire

Few-flowered navarretia (*Navarretia leucocephala* ssp. *pauciflora*)

1. Genetic studies
2. Study taxonomy
3. Study species biology
4. Develop standardized monitoring
5. Survey on private land
6. Data analysis using GIS
7. Controlled propagation, introductions, reintroductions
8. Standardize surveys/determine probability of detection
9. Determine dispersal mechanisms
10. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
11. Investigate methods to monitor ecosystem function and response
12. Study genetics in relation to potential reintroductions
13. Population viability analysis
14. Identify methods to remediate lead contamination
15. Study effects of fire, livestock
16. Develop hydrological models
17. Study vernal pool restoration methods
18. Compare constructed and natural pools
19. Systematics research
20. Study genetic structure
21. Determine effects of road run off on vernal pool species

Fountain thistle (*Cirsium fontinale* var. *fontinale*)

1. Survey historic and potential habitat
2. Research vegetation management techniques
3. Study soil seed bank
4. Investigate effect of nitrogen deposition
5. Study demography and reproduction
6. Study techniques for opening new habitat for seedlings
7. Genetic studies
8. Investigate propagation and habitat requirements

Greene's tuctoria (*Tuctoria greenei*)

1. Genetic studies
2. Study taxonomy
3. Study species biology
4. Develop standardized monitoring
5. Survey on private land
6. Data analysis using GIS
7. Controlled propagation, introductions, reintroductions
8. Standardize surveys/determine probability of detection
9. Determine dispersal mechanisms
10. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
11. Investigate methods to monitor ecosystem function and response
12. Study genetics in relation to potential reintroductions
13. Population viability analysis
14. Identify methods to remediate lead contamination
15. Study effects of fire, livestock
16. Develop hydrological models
17. Study vernal pool restoration methods
18. Compare constructed and natural pools
19. Develop methods to control weedy invasives
20. Determine effects of road run off on vernal pool species

Hairy Orcutt grass (*Orcuttia pilosa*)

1. Genetic studies
2. Study taxonomy
3. Study species biology
4. Develop standardized monitoring
5. Survey on private land
6. Data analysis using GIS
7. Controlled propagation, introductions, reintroductions
8. Standardize surveys/determine probability of detection
9. Determine dispersal mechanisms
10. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
11. Investigate methods to monitor ecosystem function and response
12. Study genetics in relation to potential reintroductions
13. Population viability analysis
14. Identify methods to remediate lead contamination
15. Study effects of fire, livestock
16. Develop hydrological models
17. Study vernal pool restoration methods
18. Compare constructed and natural pools
19. Determine effects of road run off on vernal pool species

Hartweg's golden sunburst (*Pseudobahia bahiifolia*)

1. Survey and monitor populations – last surveys ~1993
2. Conduct coordinated surveys

Hoover's spurge (*Chamaesyce hooveri*)

1. Genetic studies
2. Study taxonomy
3. Study species biology
4. Develop standardized monitoring
5. Survey on private land
6. Data analysis using GIS
7. Controlled propagation, introductions, reintroductions
8. Standardize surveys/determine probability of detection
9. Determine dispersal mechanisms
10. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
11. Investigate methods to monitor ecosystem function and response
12. Study genetics in relation to potential reintroductions
13. Population viability analysis
14. Identify methods to remediate lead contamination
15. Study effects of fire, livestock
16. Develop hydrological models
17. Study vernal pool restoration methods
18. Compare constructed and natural pools
19. Determine effects of road run off on vernal pool species

Howell's spineflower (*Chorizanthe howellii*)

1. Population monitoring
2. Disturbance monitoring
3. Remap distribution using GIS
4. Study effects of grazing
5. Determine habitat requirements
6. Monitor population trends
7. Survey likely habitat

Ione buckwheat (*Eriogonum apricum* var. *apricum*)

1. Species biology studies to address:
 - a. Disturbance regimes
 - b. Metapopulation dynamics
 - c. Seed abundance
2. Research whether disturbed areas can be restored (e.g., old mine sites)

Ione Manzanita (*Arctostaphylos myrtifolia*)

1. Investigate causes and prevention of disease
2. Identify extent of *P. cinnamoni*
3. Identify methods to prevent spread of *P. cinnamoni*
4. Species biology studies to address:

- a. Disturbance regimes
- b. Metapopulation dynamics
- c. Seed abundance
- 5. Research whether disturbed areas can be restored (e.g., old mine sites)
- 6. Map occurrences of species and disease status

Keck's checker-mallow (*Sidalcea keckii*)

- 1. Survey additional serpentine and gabbro soils in Tulare and Fresno counties
- 2. Reintroductions to protected land at Mine Hill or White River
- 3. Monitor species status and trend
- 4. Estimate population size
- 5. Estimate number and distribution of populations

Kenwood marsh checkermallow (*Sidalcea oregano ssp. valida*)

- 1. Invasive control and deer fencing
- 2. Survey Knight's Valley population
- 3. Determine effects from upstream land use and optimum hydrology
- 4. Determine effects of invasive plants and small herbivores

Kern mallow (*Eremalche kernensis*)

- 1. Conduct genetics research
- 2. Conduct matrix projection modeling

Kern primrose sphinx moth (*Euproserpinus euterpe*)

- 1. Survey for new populations
- 2. **Life history and ecology research**
- 3. Additional population genetic studies

Lake County stonecrop (*Parvisedum leiocarpum*)

- 1. Genetic studies
- 2. Study taxonomy
- 3. Study species biology
- 4. Develop standardized monitoring
- 5. Survey on private land
- 6. Data analysis using GIS
- 7. Controlled propagation, introductions, reintroductions
- 8. Standardize surveys/determine probability of detection
- 9. Determine dispersal mechanisms
- 10. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
- 11. Investigate methods to monitor ecosystem function and response
- 12. Study genetics in relation to potential reintroductions
- 13. Population viability analysis
- 14. Identify methods to remediate lead contamination
- 15. Study effects of fire, livestock
- 16. Develop hydrological models

17. Study vernal pool restoration methods
18. Compare constructed and natural pools
19. Determine effects of road run off on vernal pool species

Large-flowered fiddleneck (*Amsinckia grandiflora*)

1. Study establishment of new populations
2. Determine causes of extirpations
3. Study effect of grazing
4. Survey for additional occurrences

Layne's butterweed (*Senecio layneae*)

1. Population monitoring
2. Research on reproduction and demography including seed germination studies
3. Study importance of fire for management
 - a. Effects of fire on seedling establishment
 - b. Dynamics of seed germination and seed production and survival in soil to determine appropriate fire return period
4. Determine efficacy of other disturbance regimes (other than fire) for species and habitat management
5. Identify pollinators

Loch Lomond coyote-thistle (*Eryngium constancei*)

1. Genetic studies
2. Study taxonomy
3. Study species biology
4. Develop standardized monitoring
5. Survey on private land
6. Data analysis using GIS
7. Controlled propagation, introductions, reintroductions
8. Standardize surveys/determine probability of detection
9. Determine dispersal mechanisms
10. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
11. Investigate methods to monitor ecosystem function and response
12. Study genetics in relation to potential reintroductions
13. Population viability analysis
14. Identify methods to remediate lead contamination
15. Study effects of fire, livestock
16. Develop hydrological models
17. Study vernal pool restoration methods
18. Compare constructed and natural pools
19. Biosystematics research
20. Determine if two private sites are the listed taxon
21. Determine effects of road run off on vernal pool species

Many-flowered navarretia (*Navarretia leucocephala* ssp. *plieantha*)

1. Genetic studies
2. Study taxonomy
3. Study species biology
4. Develop standardized monitoring
5. Survey on private land
6. Data analysis using GIS
7. Controlled propagation, introductions, reintroductions
8. Standardize surveys/determine probability of detection
9. Determine dispersal mechanisms
10. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
11. Investigate methods to monitor ecosystem function and response
12. Study genetics in relation to potential reintroductions
13. Population viability analysis
14. Identify methods to remediate lead contamination
15. Study effects of fire, livestock
16. Develop hydrological models
17. Study vernal pool restoration methods
18. Compare constructed and natural pools
19. Systematics research
20. Determine effects of road run off on vernal pool species

Marin dwarf-flax (*Hesperolinon congestum*)

1. Survey historic and potential habitat
2. Research vegetation management techniques
3. Study soil seed bank
4. Investigate effect of nitrogen deposition
5. Study effects of burning
6. Genetic studies
7. Study effects of grazing
8. Investigate seed germination and propagation techniques

Mariposa pussy-paws (*Calyptridium pulchellum*)

1. Generate map of potential habitat
2. Monitor status and trends

Metcalf Canyon jewelflower (*Streptanthus albidus ssp. albidus*)

1. Survey historic and potential habitat
2. Research vegetation management techniques
3. Study soil seed bank
4. Investigate effect of nitrogen deposition
5. Investigate genetics and taxonomy
6. Research propagation and outplanting techniques

Napa bluegrass (*Poa napensis*)

Pallid Manzanita (*Arctostaphylos pallida*)

1. Study effects of fire management options
2. Assess chaparral and scrub community health
3. Habitat management research
4. Study ecology and biology
5. Surveys for species abundance and distribution
6. Determine genetic variability
7. Study reproduction and demography

Palmate-bracted birds-beak (*Cordylanthus palmatus*)

1. Genetics research on Woodland and west Madera County populations
2. Research and monitoring at Alkali Sink
3. Research at Springtown
4. Research and monitoring at Woodland and Sacramento NWR
5. Matrix projection modeling

Pennell's birds-beak (*Cordylanthus tenuis ssp. capillaris*)

1. Survey historic and potential habitat
2. Research vegetation management techniques
3. Study soil seed bank
4. Investigate effect of nitrogen deposition
5. Study burning and disturbance as management strategies
6. Research parasitic aspects of species biology
7. Work with land owners to get access to plants and create easement
8. Investigate seed germination and propagation techniques

Pine Hill ceanothus (*Ceanothus roderickii*)

1. Population monitoring
2. Fire management studies
3. Research propagation techniques

Pine Hill flannelbush (*Fremontodendron californicum ssp. decumbens*)

1. Population monitoring
2. Fire management studies
3. Research seed germination and propagation techniques

Pitkin Marsh lily (*Lilium pardalinum ssp. pitkinense*)

1. Genetic studies

Presidio clarkia (*Clarkia franciscana*)

1. Survey historic and potential habitat
2. Research vegetation management techniques
3. Study soil seed bank
4. Investigate effect of nitrogen deposition

Presidio Manzanita (*Arctostaphylos hookeri ssp. ravenii*)

1. Develop a new pure 'inbred' founder population
2. Research other methods of propagation
3. Site selection for new populations
4. Identification of existing and potential habitat in the Presidio
5. Research role of fire/smoke
6. Research seed germination

Red Hills vervain (*Verbena californica*)

1. Establish reliable baseline data for monitoring occurrences

Sacramento Orcutt grass (*Orcuttia viscida*)

1. Genetic studies (some samples may have already been collected)
2. Study taxonomy
3. Study species biology
4. Develop standardized monitoring
5. Survey on private land
6. Data analysis using GIS
7. Controlled propagation, introductions, reintroductions
8. Determine dispersal mechanisms
9. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
10. Investigate methods to monitor ecosystem function and response
11. Study genetics in relation to potential reintroductions
12. Population viability analysis
13. Identify methods to remediate lead contamination
14. Study effects of fire, livestock
15. Develop hydrological models
16. Study vernal pool restoration methods
17. Compare constructed and natural pools
18. Develop methods to control dispersal of invasive, manna grass (*Glyceria declinata*)
19. Genetic research to clarify taxonomy
20. Determine effects of road run off on vernal pool species

San Francisco lessingia (*Lessingia germanorum*)

1. Large-scale dune scrub and grassland restoration
2. Control of non-native vegetation

San Joaquin adobe sunburst (*Pseudobahia peirsonii*)

1. Survey and monitor populations – last surveys ~1993
2. Conduct coordinated surveys

San Joaquin Orcutt grass (*Orcuttia inaequalis*)

1. Genetic studies
2. Study taxonomy
3. Study species biology

4. Develop standardized monitoring
5. Survey on private land
6. Data analysis using GIS
7. Controlled propagation, introductions, reintroductions
8. Determine dispersal mechanisms
9. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
10. Investigate methods to monitor ecosystem function and response
11. Study genetics in relation to potential reintroductions
12. Population viability analysis
13. Identify methods to remediate lead contamination
14. Study effects of fire, livestock
15. Develop hydrological models
16. Study vernal pool restoration methods
17. Compare constructed and natural pools
18. Determine effects of road run off on vernal pool species

San Joaquin woolly-threads (*Monolopia congdonii*)

1. Research and monitoring
2. Matrix projection modeling
3. Trend analysis
4. Research threat of livestock

San Mateo thornmint (*Acanthomintha obovata*)

1. Survey historic and potential habitat
2. Research vegetation management techniques
3. Study soil seed bank
4. Genetic studies
5. Investigate effect of nitrogen deposition
6. Establish additional populations

San Mateo woolly sunflower (*Eriophyllum latilobum*)

1. Survey historic and potential habitat
2. Research vegetation management techniques
3. Study soil seed bank
4. Investigate effect of nitrogen deposition

Santa Clara Valley dudleya (*Dudleya setchellii*)

1. Survey historic and potential habitat
2. Research vegetation management techniques
3. Study soil seed bank
4. Investigate effect of nitrogen deposition
5. Study dispersal and connectivity
6. Investigate propagation and outplanting techniques
7. Investigate habitat requirements, especially hydrology
8. Investigate effects of grazing

Sebastopol meadowfoam (*Limnathes vinculans*)

1. Determine effects of road run off on vernal pool species
2. Research on effective eradication of non-native competitors
3. Develop and implement standardized population trend survey protocols to update status surveys, especially on private lands
4. Conduct research to assess specific physical and hydrological requirements for these species to address relationships between species occurrences and landform, soil chemistry, geographic location, and precipitation regimes
5. Conduct research on the reproductive ecology, gene flow patterns, and seed bank dynamics comparing established restoration sites and remaining natural sites to gauge restoration efficacy

Showy Indian clover (*Trifolium amoenum*)

1. Monitor populations to discern natural population fluctuations
2. Expand genetic base of Occidental population
3. Reintroduce both growth forms
4. Research effect of gophers and other disturbance regimes
5. Research tolerance to different soil types

Slender Orcutt grass (*Orcuttia tenuis*)

1. Compare genetics of Modoc Plateau with Sacramento County and other sites
2. Study taxonomy
3. Study species biology
4. Develop standardized monitoring
5. Survey on private land
6. Data analysis using GIS
7. Controlled propagation, introductions, reintroductions
8. Standardize surveys/determine probability of detection
9. Determine dispersal mechanisms
10. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
11. Investigate methods to monitor ecosystem function and response
12. Study genetics in relation to potential reintroductions
13. Population viability analysis
14. Identify methods to remediate lead contamination
15. Study effects of fire, livestock
16. Develop hydrological models
17. Study vernal pool restoration methods
18. Compare constructed and natural pools
19. Determine effects of road run off on vernal pool species

Soft birds-beak (*Cordylanthus mollis* spp. *mollis*)

1. Management of grazing
2. Effects of feral hog control
3. Seed banking

4. Population monitoring
5. Life history research
6. Surveys

Solano grass (*Tuctoria mucronata*)

1. Genetic studies
2. Study taxonomy
- 3. Study species biology**
4. Develop standardized monitoring
5. Survey on private land
- 6. Controlled propagation, introductions, reintroductions**
7. Standardize surveys/determine probability of detection
- 8. Determine dispersal mechanisms**
9. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
10. Investigate methods to monitor ecosystem function and response
11. Study genetics in relation to potential reintroductions
12. Population viability analysis
- 13. Identify methods to remediate lead contamination**
- 14. Study effects of fire, livestock, and importance of disturbance**
15. Study vernal pool restoration methods to see if disturbance will enable germination
16. Compare constructed and natural pools
- 17. Invasives research**
18. Reintroductions to Olcott Lake at Jepson Prairie
19. Assess pollination ecology
20. Identify indicators of ecosystem health
21. Determine effects of road run off on vernal pool species

Sonoma alopecurus (*Alopecurus aequalis* var. *sonomensis*)

1. Grazing trials at Point Reyes National Seashore
2. Investigate propagation techniques
3. Investigate habitat requirements
4. Survey for additional populations (survey historical sites)

Sonoma spineflower (*Chorizanthe valida*)

1. Population monitoring
2. Disturbance monitoring
3. Remap distribution using GIS
4. Study effects of grazing
5. Determine habitat requirements
6. Monitor population trends
7. Survey likely habitat

Sonoma sunshine (*Blennosperma bakeri*)

1. Determine effects of road run off on vernal pool species

2. Research on effective eradication of non-native competitors
3. Develop and implement standardized population trend survey protocols to update status surveys, especially on private lands
4. Conduct research to assess specific physical and hydrological requirements for these species to address relationships between species occurrences and landform, soil chemistry, geographic location, and precipitation regimes
5. Conduct research on the reproductive ecology, gene flow patterns, and seed bank dynamics comparing established restoration sites and remaining natural sites to gauge restoration efficacy

Springville clarkia (*Clarkia springvillensis*)

1. Establish reliable baseline data for monitoring plant occurrences in terms of population sizes and trends, number and distribution of populations, and threats
2. Work with US Forest Service, Bureau of Land Management, and California Department of Fish and Game to research the value of prescribed burning and mechanical brush removal
3. Work with US Forest Service, Bureau of Land Management, and California Department of Fish and Game to research effects of livestock grazing

Stebbin's morning glory (*Calystegia stebbinsi*)

1. Population monitoring
2. Fire management studies
3. Genetics of Nevada County population
4. Research propagation techniques
5. Determine efficacy of other disturbance regimes (other than fire) for species and habitat management
6. Investigate feasibility of habitat restoration/enhancement
7. Investigate seed production and survival in soil to determine appropriate fire return period

Succulent owls-clover (*Castilleja campestris ssp. succulenta*)

1. Genetic studies
2. Study taxonomy
3. Study species biology
4. Develop standardized monitoring
5. Survey on private land
6. Data analysis using GIS
7. Controlled propagation, introductions, reintroductions
8. Standardize surveys/determine probability of detection
9. Determine dispersal mechanisms
10. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
11. Investigate methods to monitor ecosystem function and response
12. Study genetics in relation to potential reintroductions
13. Population viability analysis
14. Identify methods to remediate lead contamination

15. Study effects of fire, livestock
16. Develop hydrological models
17. Study vernal pool restoration methods
18. Compare constructed and natural pools
19. Determine effects of road run off on vernal pool species

Suisun thistle (*Cirsium hydrophilium* var. *hydrophilium*)

1. Research extent of hybridization with *Cirsium vulgare* at Rush ranch
2. Research impact of seed predation
3. Research control measures for *Rhinocyllus conicus*
4. Survey for new occurrences

Tiburon jewelflower (*Streptanthus niger*)

1. Survey historic and potential habitat
2. Research vegetation management techniques
3. Study soil seed bank
4. Investigate effect of nitrogen deposition
5. Investigate propagation and habitat requirements

Tiburon mariposa lily (*Calochortus tiburonensis*)

1. Survey historic and potential habitat
2. Research vegetation management techniques
3. Study soil seed bank
4. Genetic studies
5. Study taxonomy
6. Investigate effect of nitrogen deposition
7. Investigate effects of public use trails and off trail hikers and dog walkers
8. Investigate germination and propagation techniques

Tiburon paintbrush (*Castilleja affinis* spp. *neglecta*)

1. Survey historic and potential habitat, especially in Santa Clara County
2. Research vegetation management techniques
3. Study soil seed bank
4. Genetic studies
5. Investigate effect of nitrogen deposition
6. Investigate propagation
7. Investigate habitat requirements
8. Investigate life history

Vine Hill clarkia (*Clarkia imbricate*)

1. Survey historic and potential habitat

White sedge (*Carex albida*)

1. Genetic analysis

White-rayed pentachaeta (*Pentachaeta bellidiflora*)

1. Survey historic and potential habitat
2. Research vegetation management techniques
3. Study soil seed bank
4. Investigate effect of nitrogen deposition
5. Experimental reseeding
6. Reintroduction to protected, suitable locations
7. Investigate seed germination and propagation techniques

Yellow larkspur (*Delphinium luteum*)

1. Conduct status surveys; survey historical and potential habitat
2. Locate suitable habitat for reintroductions
3. Research outplanting techniques

INVERTEBRATES

Bay checkerspot butterfly (*Euphydryas editha bayensis*)

1. Determine effects of nitrogen deposition
2. Research on methodology for artificial rearing
3. Determine effects of grazing, fire, and mowing
4. Investigate importance of other nectar plants
5. Study reason for limited reproductive success

California freshwater shrimp (*Syncaris pacifica*)

1. Monitor and evaluate habitat conditions and populations
2. Determine preferred habitat
3. Conduct research on:
 - a. Feeding ecology
 - b. Population characteristics
 - c. Dispersal
4. Range-wide surveys

Callippe silverspot butterfly (*Speyeria callippe callippe*)

1. Surveys to determine distribution
2. Genetic studies to determine relationships among subspecies
3. Study host plant use
4. Investigate role of nectar resources
5. Habitat restoration
6. Vegetation management
7. Determine abiotic habitat characteristics
8. Captive propagation
9. Reintroductions
10. Study effects of air pollution/nitrogen deposition

Conservancy fairy shrimp (*Branchinecta conservatio*)

1. Genetic studies
2. Study taxonomy

3. Study species biology
4. Develop standardized monitoring
5. Survey on private land
6. Data analysis using GIS
7. Cyst bank dynamics
8. Controlled propagation, introductions, reintroductions
9. Standardize surveys/determine probability of detection
10. Determine dispersal mechanisms
11. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
12. Investigate methods to monitor ecosystem function and response
13. Study genetics in relation to potential reintroductions
14. Population viability analysis
15. Identify methods to remediate lead contamination
16. Review existing shrimp cyst collection, storage, and application mechanisms and success
17. Develop site-specific mechanisms and success criteria for shrimp cyst collection storage and application
18. Study effects of fire, livestock
19. Develop hydrological models
20. Study vernal pool restoration methods
21. Compare constructed and natural pools
22. Determine if early drying of Olcott impacts survival and reproduction
23. Determine effects of road run off on vernal pool species

Delta green ground beetle (*Elaphrus viridis*)

1. Genetic studies
2. Study taxonomy
3. Study species biology
4. Develop standardized monitoring
5. Survey on private land
6. Data analysis using GIS
7. Controlled propagation, introductions, reintroductions
8. Standardize surveys/determine probability of detection
9. Determine dispersal mechanisms
10. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
11. Investigate methods to monitor ecosystem function and response
12. Study genetics in relation to potential reintroductions
13. Population viability analysis
14. Identify methods to remediate lead contamination
15. Study effects of fire, livestock
16. Develop hydrological models
17. Study vernal pool restoration methods
18. Compare constructed and natural pools
19. Captive breeding research

20. Research on life history characters
21. Determine effects of road run off on vernal pool species

Lange's metalmark butterfly (*Apodemia mormo langei*)

1. Grazing research
2. Annual population monitoring
3. Research of life history, habitat requirements

Longhorn fairy shrimp (*Branchinecta longiantenna*)

1. Genetic studies
2. Study taxonomy
3. Study species biology
4. Develop standardized monitoring
5. Survey on private land – see specific areas in five-year review
6. Data analysis using GIS
7. Controlled propagation, introductions, reintroductions
8. Standardize surveys/determine probability of detection
9. Determine dispersal mechanisms
10. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
11. Investigate methods to monitor ecosystem function and response
12. Study genetics in relation to potential reintroductions
13. Population viability analysis
14. Identify methods to remediate lead contamination
15. Review existing shrimp cyst collection, storage, and application mechanisms and success
16. Develop site-specific mechanisms and success criteria for shrimp cyst collection storage and application
17. Study effects of fire, livestock
18. Develop hydrological models
19. Study vernal pool restoration methods
20. Compare constructed and natural pools
21. Surveys on private lands that shown high probability of supporting longhorn fairy shrimp
22. Develop restoration and reintroduction methods
23. Study competition and coexistence with Vernal Pool Fairy Shrimp in east Contra Costa County
24. Determine effects of road run off on vernal pool species

Mission blue butterfly (*Icaricia icariodes missionensis*)

1. Inventory butterflies and food plants
2. Conduct annual surveys of butterflies and food plants
3. Determine synecological relationships
4. Determine biological requirements of food plants
5. Investigate biology of tending ant species
6. Identify perturbation processes

7. Determine necessary size of colonies
8. Determine necessary habitat quality and quantity

Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*)

1. Annual surveys of three known populations
2. Conduct life history and behavior research
3. Conduct surveys throughout known range to find new populations

San Bruno elfin butterfly (*Callophrys mossii*)

4. Inventory butterflies and food plants
5. Conduct annual surveys of butterflies and food plants
6. Determine synecological relationships
7. Determine biological requirements of food plants
8. Investigate biology of tending ant species
9. Identify perturbation processes
10. Determine necessary size of colonies
11. Determine necessary habitat quality and quantity
12. Re-establish populations

Shasta crayfish (*Pacifastacus fortis*)

1. Monitor barrier created by culverts and fortify
2. Survey Lava Creek for signal crayfish, install barriers, eradicate signal crayfish as appropriate
3. Feasibility study for installing barrier at outflow of Big Lake into the Tule River
4. Assess and develop barrier for Crystal Cove and Crystal Inlet
5. Develop alternative levee maintenance practices
6. Flume studies to test barrier designs
7. Determine recharge area for Fall River
8. Estimate Shasta crayfish abundance and develop targets for sustainable, well-distributed population
9. Determine food preferences and nutritional requirement
10. Determine effects of signal crayfish
11. Determine effects of cross-mating
12. Determine effects of pathogens
13. Genetic studies

Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)

1. Determine optimum habitat for reintroductions

Vernal pool fairy shrimp (*Branchinecta lynchi*)

- 1. Genetic studies**
2. Study species biology
3. Develop standardized monitoring
4. Survey on private land
5. Data analysis using GIS – what occurrences have been extirpated
6. Controlled propagation, introductions, reintroductions

- 7. Determine whether new populations are from inoculum or reproduction**
8. Standardize surveys/determine probability of detection
9. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
10. Investigate methods to monitor ecosystem function and response
11. Study genetics in relation to potential reintroductions
12. Population viability analysis
13. Identify methods to remediate lead contamination
14. Review existing shrimp cyst collection, storage, and application mechanisms and success
15. Develop site-specific mechanisms and success criteria for shrimp cyst collection storage and application
16. Study effects of fire, livestock, and other disturbance
17. Develop hydrological models
18. Study vernal pool restoration methods
19. Compare constructed and natural pools
- 20. Assess number of demographically independent units**
- 21. Determine levels of migration**
22. Determine long-term trends in population growth
23. Experimentally measure probabilities of local extinction and colonization
24. Examine long-term hydrological effects
25. Research egg bank dynamics
26. Determine probability of detection for wet and dry season surveys
27. Determine effects of road run off on vernal pool species

Vernal pool tadpole shrimp (*Lepidurus packardii*)

1. Genetic studies
2. Study taxonomy
3. Study species biology
4. Develop standardized monitoring
5. Survey on private land
6. Data analysis using GIS
7. Controlled propagation, introductions, reintroductions
8. Standardize surveys/determine probability of detection
9. Determine dispersal mechanisms
10. Investigate methods to remediate contamination by herbicides, salt, industrial chemicals
11. Investigate methods to monitor ecosystem function and response
12. Study genetics in relation to potential reintroductions
13. Population viability analysis
14. Identify methods to remediate lead contamination
15. Review existing shrimp cyst collection, storage, and application mechanisms and success
16. Develop site-specific mechanisms and success criteria for shrimp cyst collection storage and application
17. Study effects of fire, livestock

18. Develop hydrological models
19. Study vernal pool restoration methods
20. Compare constructed and natural pools
21. Standardized formal monitoring protocol
22. Determine extent of distribution
23. Improvement of presence-absence survey guidelines
24. Determine effects of road run off on vernal pool species

AMPHIBIANS

California red-legged frog (*Rana aurora draytonii*)

1. Develop surveying and monitoring protocol
2. Conduct surveys: Tehachapi Mountains, Santa Monica Mountains, Sisquoc River, Upper Salinas River, Carrizo Plain, and historic and current Sierra Nevada range
3. Develop population monitoring program
4. Conduct population viability analyses for metapopulations
5. Study upland use, dispersal habits, and overland movements
6. Investigate contaminants issues
7. Investigate effects of mosquito fish
8. Determine genetic and ecological relationships between *R. a. draytonii* and *R. a. aurora*
9. Determine if distinct population segments are present
10. Experimental habitat manipulations
11. Determine effect of livestock waste
12. Determine grazing thresholds
13. Determine effects of Eucalyptus
14. Study frog-turtle interactions

California tiger salamander, Sonoma County (*Ambystoma californiense*)

1. Monitor to determine metamorphic success of cohort
2. Research success of underpasses
3. Determine effects of road run off on vernal pool species

California tiger salamander, central (*Ambystoma californiense*)

1. Determine function of permanent ponds in dynamics of larval survival and phenology of prey
2. Assessment of upland habitat
3. Study effects of hypoxia and vegetation load
4. Determine effects of road run off on vernal pool species

REPTILES

Alameda whipsnake (*Masticophis lateralis euryxanthus*)

1. Study effects of fire management options
2. Assess chaparral and scrub community health
3. Habitat management research

4. Study ecology and biology
5. Surveys for species abundance and distribution
6. Determine genetic variability
7. Study reproduction and demography

Blunt-nosed leopard lizard (*Gambelia sila*)

1. Metapopulation genetics research
2. Conduct metapopulation viability analysis
3. Census and monitoring
4. Study effects of translocations and agricultural land retirement

Giant garter snake (*Thamnophis gigas*)

1. Identify areas of high GGS concentration
2. Identify corridors for GGS movement
3. Study water quality and toxicology issues
4. Study response of GGS to fallowing of rice fields
5. Install and study use of roadway box culverts for snake passage
6. Range-wide surveys
7. Determine habitat requirements
8. Determine salinity tolerance

San Francisco garter snake (*Thamnophis sirtalis tetrataenia*)

1. Population estimation
2. Determine population trends and demographic structure
3. Determine level of hybridization and genetic relatedness

BIRDS

California clapper rail (*Rallus longirostris obsoletus*)

1. Study research methods for ditching and mosquito abatement
2. Study research methods for control and eradication of *Spartina alterniflora* and hybrids
3. Study research methods for eradication of *Lepidium latifolium*
4. Develop system for early detection of invasive plants
5. Study establishment of satellite populations
6. Study transition from dyked wetlands to tidal marsh
7. Surveys and annual counts
8. Monitor survival and mortality at all life stages
9. Study rail population ecology
10. Determine effects of *Spartina* treatments on rails
11. Rail diet analysis
12. Determine sedimentation rates
13. Study human-caused freshwater discharges
14. Study effects of salinity fluctuations
15. Study physical processes that maintain suitable habitat
16. Study effects of global warming

17. Conduct contaminants research

MAMMALS

Buena Vista Lake shrew (*Sorex ornatus relictus*)

1. Conduct census
2. Study demography
3. Study dynamics and effects of habitat enhancements
4. Introductions/reintroductions
5. Study effects of pesticide use and drift
6. Population genetics
7. Study effects of selenium

Fresno kangaroo rat (*Dipodomys nitratooides exilis*)

Giant kangaroo rat (*Dipodomys ingens*)

1. Habitat restoration
2. Reintroductions
3. Fungus and respiratory problems (potential emerging issue)
4. Identify components of diet
5. Grazing effects related to density

Riparian brush rabbit (*Sylvilagus bachmani riparius*)

1. Population genetics
2. Determine whether populations are self-sustaining without input from captive breeding program

Riparian woodrat (*Neotoma fuscipes riparia*)

1. Population genetics
2. Study methodology and success of reintroductions
3. Determine habitat requirements

Salt marsh harvest mouse (*Reithrodontomys raviventris*)

1. Study research methods for ditching and mosquito abatement
2. Study research methods for control and eradication of *Spartina alterniflora* and hybrids
3. Study research methods for eradication of *Lepidium latifolium*
4. Develop system for early detection of invasive plants
5. Study habitat quality from dyked wetlands to tidal marsh
6. Surveys and annual counts
7. Determine sedimentation rates
8. Study human-caused freshwater discharges
9. Study effects of salinity fluctuations
10. Study physical processes that maintain suitable habitat
11. Study effects of global warming
12. Conduct contaminants research

13. Movement studies
14. Determine impact of non-native *Spartina* on mice
15. Study predation rates
16. Develop diagnostic test to distinguish between salt marsh and western harvest mice
17. Population genetics

San Joaquin kit fox (*Vulpes macrotis mutica*)

1. Estimate habitat area as of publication of Recovery Plan:
2. Census and demography research
3. Predict and maintain compatible land uses
4. Determine interactions and effects of red foxes, coyotes, feral dogs
5. Metapopulation genetics
6. Refine metapopulation viability analysis
7. Conduct range-wide surveys and surveys at edges of known range
8. Determine direct and indirect effects of rodenticides
9. Investigate source-sink dynamics in corridors and small parcels
- 10. Determine dietary energetics of various prey bases (k-rats, ground squirrels, etc)**

Tipton kangaroo rat (*Dipodomys nitratoides nitratoides*)

1. Conduct metapopulation viability analysis